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A Research and Development plan for the introduction of Integrated Pest Management in the Ethiopian Rose Sector

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Plant Research International B.V., Wageningen
February 2007

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1. Acknowledgements

We would like to express our gratitude to all growers, scientists and ministerial representatives who took the time, effort and enthousiasm to meet with us. Whether our visits were announced or totally unexpected, we never met a closed gate or door.

We also would like to thank Mr. Geert Westenbrink, Agricultural Councellor of the Netherlands Emabassy in Addis Ababa, Woukje Westenbrink, and Embassy staff for facilitating in various ways our mission and making our stay such a pleasant one.

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Wageningen,
February 2006

2. Summary

PLEASE NOTE:
THIS IS A DRAFT REPORT. WE WELCOME ANY COMMENT.

All parties involved agree upon the advantages of Integrated Pest Management (IPM) in Ethiopian rose production. There should be no *a priori* limitation to the introduction of IPM including biological control. Transport facilities, willingness by farmers, consumers' zero-tolerance to chemical residues, positive experiences in other countries, and growing cooperation between growers, researchers and government are some of the enabling factors. However, the introduction will not be a matter of simply changing pesticide use, or of adopting a technology. The key factor will be the growing confidence of growers to be involved in and contribute to the process of developing a more sustainable rose production in Ethiopia. We suggest that informal (on-farm) research and capacity development (Growers First approach) should be the starting point, both in terms of problem definition and technology development.

Instead of promoting the transfer of ready-made techniques as fixed prescriptions, a more integrated, site-specific approach to development is necessary to solve the many problems related to sustainability in crop protection and production. Growers' perceptions of the risks involved in the use of sustainable methods as biological control agents demands local try-outs of standards that are developed elsewhere. Experts can assist growers in starting experiments and in analyzing results. Formal research must be designed in such a way that it allows for flexibility and will not turn growers into consumers of technology. Promotion of grower-to-grower exchange, support of information systems to link growers, research and training are vital in the development of IPM.

A supportive institutional framework is a prerequisite for the science-practice continuum, requiring a long-term view and associated agenda. This will include some of the following elements:

- integration of informal and formal research
- capacity building of growers/farm managers and scientists alike
- close involvement of the suppliers of biological control agents
- governmental support policy and implementation, in the short term resulting in a procedure for granting a permit to import biological control agents
- international cooperation

Two-spotted spider mite is the major pest problem in Ethiopian rose production, followed by thrips. All parties agree that two-spotted spider mite should be dealt with first. We suggest to start on-farm trials at five farms that vary in their altitude and associated climate, production and stem type. However, trials can only start after an permit for biological control agents has been granted.

<u>We analyzed the risks associated with the import of biological control agents for spider mite and thrips, and come to the conclusion that all risks have been adequately dealt with. We therefore see no technical reason for not granting an import permit.</u>

3. Introduction

3.1. Rationale

Ethiopian export horticulture is developing at a unique and unexpected high speed. In 2000, 9 ha were under flowers, which had increased to over 600 hectares in 2006. In 2005/2006 the export value was $26 million, while for the year 2006/2007 an export at a value of $ 113 million is expected. It is estimated that currently over 25,000 jobs have been created in the floriculture sector. With this rapid growth Ethiopia has surpassed in a few years time all other African countries, except Kenya. Next to the positive impacts in terms of foreign exchange, economic development and creating employment, the floriculture also provides an inspiring example of a successful introduction of advanced labour-intensive production technology and is successfully meeting demands of consumers markets in West Europe. The export of fruits and vegetables is less developed, but is expected also to develop further in the coming years.

With the rapid development of the sector public concerns within and outside Ethiopia are growing regarding labour conditions at the farm, the environmental impact (over-exploiting water resources), and human health due to the use of pesticides and fertilizers. In response to these concerns the Ethiopian Horticulture Producers and Exporters Organization has taken the initiative to develop a code of conduct. The development of this code of conduct (including a plan for implementation) is supported by the Royal Netherlands Embassy in Addis Ababa.

The heavy use of pesticides in current Ethiopian rose cultivation has introduced the following consequences:

- Market
    - Pesticides account for 25% of expenditures. Rose growers are most eager to reduce this through the introduction of (cheaper) biological control agents, which improves to the economic situation of the sector.
    - Export increasingly demands low residue levels (certification).
    - An estimated 10% yield reduction due to phytotoxicity of pesticides directly on the crop.
    - Shortening longevity of plastic cover, caused by the S-compounds in chemicals, and in combination with the high UV-levels at relatively high altitudes.
- Control
    - Resistance development by the pests to pesticides, leading to un-controllable pest pressure with associated yield reduction.
- Image of the sector & workers' health
    - Complaints from workers and neighbouring farmers.

For these reasons, all stakeholders involved in the development of the code of conduct agree that alternative pest control strategies are needed. Integrated Pest Management (IPM) brings together various control strategies, and can therefore make a big contribution to realizing the code of conduct. Experts both in the commercial as well as from the scientific side see good possibilities for the introduction of IPM, given the successful introductions in Zimbabwe and Kenya. For Ethiopia, one Dutch firm specialized in IPM has already shown concrete interest in starting activities in Ethiopia.

It should be stressed that rose growers in Ethiopia see an urgent need for implementation of Integrated Pest Management. It will create a competitive market advantage. Without IPM, there exists a serious danger of losing market share to growers in countries where certification schemes have realized the use of IPM.

3.2. Integrated Pest Management (IPM) in Ethiopia

IPM is not yet wide-spread in the Ethiopia floriculture. The use of agro-chemicals to control pests and diseases is known to be unsustainable in the long run, to be potentially harmful to the environment and to negatively affect working conditions, form a danger for employees and often leads to unacceptable high levels of residues in the products and resulting in. It therefore has to be avoided that an increase of the floral cultivation is accompanied by a similar increase of agro-chemicals. Instead, an IPM research and development has to be defined in such a way that this approach responses to the negative economic and ecological side-effects arising from high prophylactic use of pesticides to control pests and diseases This is a matter of some urgency, given the rapid pace of sector development.

The value chain analysis suggests that the costs of agrochemical inputs such as spraying constitutes a high proportion of the flower farming value chain. Over 92% of spraying costs go for agrochemicals (Global Development Solutions, 2006). Actually, the majority of chemicals are imported by the growers themselves.

In Ethiopia, legal instruments pertaining to chemical management are non-existent, overlapping or fragmented. The overall result of this fragmented system is that it inhibits the emergence of an integrated information network that collects, stores, and disseminates the latest information on banned substances, use and proper disposal of pesticides as well as to raise awareness on best practice in fields like integrated pest management. Actually, links between the distribution channels for grower information and the channels for research-oriented information are weak.

The development of integrated crop and pest management is crucial to enhance the opportunities in the production of high quality products. In order to support this development, it is necessary that crop production goes hand in hand with the optimisation of the indoor abiotic conditions and an environmentally friendly growing system including integrated pest management.

Integrated pest management is a holistic approach to pest control in which multiple practices are implemented throughout the entire production period of the crop. Crop monitoring is the foundation of an IPM programme. Crop monitoring provides heightened awareness of pest presence, activity and control. It addresses the real needs of the crop, reduces pesticide use by eliminating unnecessary, routine applications and assures pesticides applied at the proper life-cycle stage to insure effectiveness. Success of IPM at the production level will depend on:

- Growing a healthy crop
- Combining of control strategies, in which **pesticide use is the last step**
- High science, low technology
- Change in attitude (reliance on own observations and experiences at the farm level)
- Adequate technology development combining informal and formal research using a “grower first approach” in technology development.

Steps forward in Ethiopian IPM are (Figure 1):

1. from prophylactic (preventive) use of chemicals
2. to guided control based on field observation,
3. to integrated pest management in which a healthy crop is a cornerstone and sanitation, biological control are essential elements, while pesticide use the last solution is.

Consequences for IPM research and development are:

- An enabling environment in which technology development (informal research system) is linked with formal research and training of the future generations
- Rules and legislation with more precise guidance on issues such as banned chemicals, and the import of beneficial insects
- Institutional linkeages and partnerships including the transformation of the institutional culture to allow a better accommodation of issues relevant at growers’ level

- Relevant research and development priorities setting based on the problems and growers'need
- Knowledge exchange
  - E.g., demonstration trials, training.
  - Study groups and group work (growers, Ambo Research, Jimma University, scouts) which stimulate individual and collective reflection on measurements, and experimentation with new methods and the acceptance of new norms of appropriate behaviour (GAP, Eurogap, MPS certification programme).

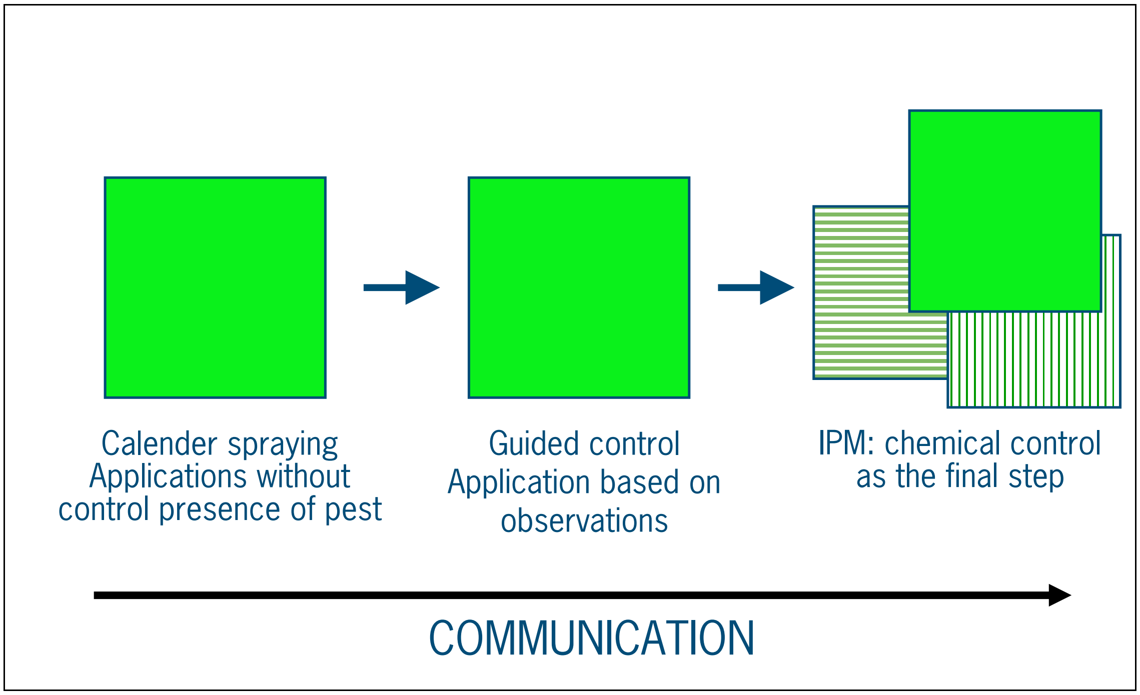

Figure 1. Envisaged steps forward in Ethiopian IPM.

3.3. Terms of Reference

The Netherlands Government has committed itself to contribute to a balanced growth of the horticulture sector in Ethiopia through a public-private partnership program along similar lines as the WSSD partnership programmes with other countries in Southern and Eastern Africa (The Ethiopian-Netherlands Horticulture Partnership).Jointly with the stakeholdes a plan of activities was formulated in 2006, which consists of the following topics:

1. capacity building in the floriculture sector in Ethiopia
2. code of conduct for the sector
3. capacity building phytosanitary unit
4. market information service
5. integrated pest management
6. decision support model for location of flower production
7. identification of competitive product-market combinations for fruits and vegetables
8. implementation of EUREPGAP.

The IPM project (sub-project #5) is meant to develop a comprehensive research and development plan for a systematic and responsible introduction of IPM. The project looks into the technical as well as in the institutional aspects. The project has linkeages with especially projects #1 (training component), 2 (reduction of chemical residues, improved labour conditions, adherence to protocols for Good Agricultural Practices), 3 (a protocol for the import of biological control agents) and 8 (certification).

The mission's Terms of Reference were as follows:

Research:

1. Develop with Ethiopian Agricultural Research Institute and Jimma Agricultural University a research plan, including the involvement of students.
2. Explore options for PhD students

Demonstration:

3. Identify farms that are suitable for IPM demonstration.
4. Discuss technical issues connected to the introduction of IPM.
5. Discuss the possibility of a Growers' Study Club.

Extension and training:

6. Discuss the options for a knowledge dissemination plan.
7. Evaluate the extension issues connected to the introduction of IMP.

Enabling environment:

8. Evaluate with the Department of Plant Protection desired rules and regulations for a smooth and controlled importation of predators.
9. Evaluate institutional and regulatory framework / issues connected to the introduction of IMP.
10. Develop coherence with Strategy for Capacity Building in the Export-Oriented Floriculture Sector in Ethiopia (upon return in Wageningen).

3.4. Approach

The Ethiopian floriculture sector will benefit from a well-working interaction between the public and private sectors, in which Ministries, research organizations and reliable companies operate to fulfill the needs of the rose sector. The mission's task was to independently of any organization and company provide a situation assessment. It is ultimately up to the rose growers to select the supplier of biological control agents, provided the supplier operates within the applicable laws and regulations.

Prior to the mission, a literature study was conducted with respect to IPM experiences in protected rose cultivation in comparable countries.

Also, Mr. Edwin vander Maden, student from Wageningen UR interviewed from September to November 2006 a total of 33 growers, which resulted in a base-line assessment.

The mission itself held interviews and meetings with:

- 10 growers (7 rose, 2 open-field beans, 1 greenhouse vegetables)
- The director and 29 scientists of the Plant Protection Research Centre, at Ambo, of the Ethiopian Agricultural Research Institute
- The Dean and pathologist of College of Agriculture and Veterinary Medicine, Jimma University
- Representatives of the Ministry of Agriculture and Rural Development
- Representatives of the Ministry of Trade and Industry
- The Deputy Director General of the Ethiopian Agricultural Research Institute
- Representatives of USAID
- The intended director of the Vocational Training Centre

4. Present situation

4.1. Literature survey

A literature survey was conducted to assess the IPM experiences in protected rose cultivation in other countries with similar growing conditions that were of relevance for the implementation of a research and development plan for IPM in rose cultivation in Ethiopia. The initiatial goal was not only to describe general experiences, but also to identify advantages, disadvantages, risks and limitations. Globally, experiences with Integrated Pest Management under open-field conditions and under protected cultivation have been widely documented. However, when focusing on protected rose cultivation, the amount of available information was reduced considerably. Surprisingly little has been published in refereed and not-refereed scientific literature and in more popular journals, and also a thorough search on the web resulted in just a limited number of publications. More specifically, literature on experiences in countries such as Colombia, Equador, Kenya, Zambia and Uganda turned out to be extremely scarce.

Therefore, the intial goal of the literature survey had to be set aside as being too ambitious. Below is summarized the few bits of information that could be gathered from scientific literature, non-scientific publications and websites. If applicable, we included documentation of IPM experiences in Ethiopia irrespective of the crop.

IPM techniques can be separated in two major groups: relatively straightforward replacements for chemicals, and supporting measures. The first group can be distinguished in (SP-IPM, 2006):

- Biological control: the introduction of insects, mites, micro-organisms that prey on or parasitize harmful species
- Biopesticides have a pathogenic micro-organisms as active ingredient, for example a bacterium, a virus, etc. (for example, Bt)
- Botanicals: botanical pesticides contain plant extracts that have biocidal properties (for example, neem).
- Semiochemicals: insects and other species that stimulate particular behaviour or interactions between individuals are used to manipulate behaviour in order to control pests (for example, the excretion of pheromones).
- Transgenic organisms.

Choosing biological alternatives to chemical pesticides is rarely a straightforward decision (SP-IPM, 2006), given possibly various options and the advanced understanding of the interactions between environment, crop, pest and predator. In farmer field schools the various issues are addressed, from scouting to agro-ecosystem analysis. The scientific basis for farmer decision making in biological control depends on detailed knowledge of the life histories of pest and their natural enemies, crop ecology, and interactions within the agro-ecosystem. Farmer participation and learning are essential.

4.1.1. Kenya

Whitaker & Kolavalli (2004) identified, amongst others, the following factors contributing to the causes of success of the Kenyan floricultural industry:

a. Relatively little government intervention.
b. Relatively high and steady profit margins.
c. The ability of Kenyan firms to capitalize on the increasing globalization of flower production and trade.
d. The fact that Europe knows an off-season for flower production.
e. Steadily increasing European and North America demand.

Challenges have been many, but a few were:

a. Upgrading the flower quality to international standards.
b. Implementing industry Codes of Practice on environmental and social performance.
c. Dependency on imported plant material, structures and equipment, and technical and managerial expertise
d. Economies of scale.
e. Expansion of floriculture to neighbouring countries, which has not been at the expense of Kenya's flower industry. Kenya is expected to maintain competitive advantage.

With regards to the Code of Practice, concerns included the use of pesticides and water. Knowledge-based technologies such as IPM and water-reducing technologies (e.g., hydroponics) have been adapted to local conditions and disseminated. Of relevance here are the Dutch 'Milieu Project Sierteelt' (MPS), the Flower Label Programme (FLP), Eurep-GAP, and self-regulation codes by the Kenya Flower Council (KFC) and the Fresh Produce Exporters Association of Kenya (FPEAK). The codes focus on the use of knowledge-based (such as IPM) rather than chemical-based technologies and to some extent require local technology development. Local firms such as Homegrown and Real IPM have taken up research, consultancy and training.

Nyalala (2005) mentios that in Kenya, 40% of the pesticide volume applied to rose crops and over 30% of the total costs of pest control are accounted for by miticides. This mainly concerns the management of spider mite. Costs, toxicity and hazards to human health, consumers' zero-tolerance to chemical residues on flowers, avoiding the build-up of pesticide resistances, increasing production of organic production of crops, are factors stimulating the adoption of biological control methods. These include the use of biological control agents, insecticidal soap and soybean oil (without much success) and the African spider plant (*Cleome gynandra*) with insecticidal properties.

Koppert (Moerman, 2006) has proven the effectiveness of *Phytoseiulus* against spider mite.

In looking for market expansion, Japan remains a difficult market to access, not only due to high freight costs, but also due to strict plant quarantine regulations requiring plants to be fumigated if any insects are found (Anonymous, 2005).

4.1.2. The Netherlands and the USA

Companies that are most renowned are Koppert and Syngenta (we do not mean to disqualify any other company). In close collaboration with the scientific community (e.g., Wageningen University and Research Centre, and Davis University, California) such companies have over the last decades successfully made available to farmers biological control methods. The development of the IPM industry has benefited much from the translation of solid scientific work to very simple practical control methods, in which (costly) labour inputs had to be minimized. This was accompanied by a long-lasting learning process by farmers. Continuously, new biological control agents are tested and released.

In The Netherlands, biological control was stimulated by the government through efforts in basic research and applied research. This was driven by a combination of increasing labour costs, consumer aversion to pesticides, an initial group of growers that were convinced that biological control would be effective, a group of suppliers, and governmental financial support. Now, new pesticides must be evaluated for their effect on 'useful arthropods', which stimulates biological control (Vijverberg, 2006). Specifically in case of roses, the dense foliage makes it difficult to spray for spider mite; this mechanical barrier has been an important reason for Dutch growers to adopt biological control. Currently, approximately 20% of the Dutch growers uses biological control (Evans, 2005).

4.1.3. Ethiopia – pests and diseases

Abate (2006) states that 'a fair amount of knowledge exists on IPM of several crop pests in Ethiopia. Some of it has already been put into practical use, some studies are currently ongoing, and a lot remains to be done in the times ahead. The focus appears to be on migratory insect pests such as the African armyworm (*Spodoptera exempta*), the African migratory locust (*Locusta migratoria migratoroides*) and the desert locust (*Schistocerca gregaria*) and on a number of regular (non-migratory) insect pests in open-field crops. It appears that a renewed effort is required, with more attention for insect pests of relevance to protected cultivation.

Morris (2006) mentions as the major pests and diseases encountered by Ethiopian rose farmers:

Scientific name	Common name	Scale of problem	Environmental conditions
Pests			
Tetranychus urticae	Two-spotted red spider mite	serious	Dry season – all year
	Aphids	occasional	
	Whiteflies	occasional	
	Thrips	occasional	
	Caterpillars	occasional	
Diseases			
Botrytis cinerea	Grey mould	serious	Wet season, high altitude
Peronospora sparsa	Rose downey mildew	serious	Wet season, high altitude
Sphaerotheca pannosa var. rosae	Rose powdery mildew		Dry season
Agrobacterium tumefaciens	Crown gall	Emerging	Soil-borne, imported through young plants

4.1.4. Ethiopia – research priorities

Morris' (2006) recommendations for cultural control methods include:

- scouting
- good hygiene
- avoidance of stress: correct fertigation, pruning and maintenance
- improved air circulation, reduced air humidity
- sanitation

In addition, Abate (2006) mentions that it might be worthwhile to consider (at least, not to forget) traditional methods of pest control as used in subsistence farming systems: cultural control (e.g., intercropping), habitat manipulation (e.g., creating diversity), mechanical and physical control, natural biological systems, host plant resistance, and use of locally available materials.

4.1.5. Ethiopia – enabling environment

Ammerlaan (2005), in analyzing the chances for the Ethiopian floriculture, rated factors having an influence on the rose production industry (see Table 1). Although he dit not pay specific attention to IPM, the following factors positively influencing the introduction of IPM in Ethiopia can be identified:

- costs of skilled labour (for scouting and application of the biological control agent),
- quality road network, air transport (for the speedily delivery of the biological control agent),
- market prospects (stimulation growth of the industry, and quality of the produce).

The following factors require attention:

- availability and quality of skilled labour and knowledge resources, and management capacities (IPM capacity building),
- availability of road transport (hampering the speedily delivery of the biological control agent)
- governmental position (for IPM enabling the import of biological control agents).
-

With regards to capacity building, Azerfegne (2006) describes the crop protection curricula at the Agricultural Universities in Ethiopia. Crop protection is a major component of the agricultural colleges. The undergraduate science programme adequately provide an overview, however, 'are deficient in presenting case studies and examples of national experiences owing to the limited research outputs and lack of organized information on the existing results'. Funding, facilities and networking are insufficient. In graduate programmes, the share of expatriate staff is too large, leading to insufficient knowledge of the local situation. Research output is not sufficiently distributed. The conclusion is that knowledge generation and sharing should be improved.

Table 1. Factors influencing the Ethiopian rose production industry (Ammerlaan, 2005).

Category	Negative (score 1-2)	Neutral (score 3)	Positive (score 4-5)
Factor conditions			
Human resources	Availability of skilled labour		Availability of unskilled labour
	Productivity of unskilled labour		Cost of unskilled labour
			Cost of skilled labour
Physical resources	Availability of land	Availability of water	Climate
			Cost of land
			Quality of water
Knowledge resources	Availability of knowledge		
	Quality of knowledge		
	Cost of knowledge		
Capital resources		Availability of capatal	Cost of capital
			Presence of capital
Infrastructure	Telecom	Quality of airport facilities	Quality of road network
		Power	
		Attractiveness to live and work	
Demand conditions			
	Domestic market conditions	Accessibility foreign market	Foreign market size
	Quality of products	Market information	Market growth
Related and supporting industries			
Agricultural suppliers		Availability of materials	Sustainability of industry
		Competitiveness in industry	
		Cost of materials	
Transport	Availability of road transport		Costs of road transport
	Quality of road transport		Availability of air transport
	Quality of air transport		
Supporting industry		Finance institutions	Horticulture association
Firm strategy, structure and rivalry			
Strategy		Culture	
		Adaptability	
		Pricing strategy	
Structure	Managerial capabilities	Flexibility	
		Structure of companies	
Rivalry	Market power of buyers	Market power of suppliers	Cooperation between growers
		Threats of new entrants	
Chance			
	Political stability	Economic stability	Market price stability
	Health of inhabitants		Crime
Government			
	Government authorities		Support of government
			Trade policy
			Land reform policy
			Fiscal policy

4.2. Base-line survey

4.2.1. Introduction

Mr. Edwin vander Maden, MSc student of WUR, conducted during September – November 2006 a base-line survey. A number of questions regarding farm management and pest, disease and weed management were incorporated. The results of this survey are summarized below.

4.2.2. Farm characteristics

Data on 33 farms were gathered. Twenty-seven farms are growing roses in greenhouses, while other farms are growing cuttings or were propagating roses and other flowers (*Gyphsophillia*, *Carnation*, *Hypericum*, *Ranuncula*, *Delfenia*, *Eryngium*). Average rose farm size is 8.4 ha, with minimum and maximum acreages of 2.3 and 27 ha, respectively.

Table 2. Farm sizes in Ethiopian floriculture.

	# farms	Farm size (ha)		
		Av	Min	Max
Roses in greenhouse	27	8.4	2.3	27
Other cut flowers in greenhouse	3	5.2	0.5	8.5
Other cut flowers in open field	7	6.5	0.6	12.0
Cuttings or propagation roses in greenhouse	6	0.6	0.2	2.0
Cuttings or propagation roses in open field	1	1.0	1.0	1.0
Other cuttings or propagation in greenhouse	2	2.6	1.0	4.2

Some other farm characteristics:
- 91% of the greenhouses has plastic foil cover;
- 67% of the greenhouses has a top cover that can be flexibly opened, and 18% has a permanently open top cover;
- 69% of the growers is growing the crop in the soil, 25% on a substrate, and 6% is using both soil and substrate;
- the most commonly used substrate used is red ash;
- soil types vary considerably, depending on the location in Ethiopia;
- 73% uses automated climate control, predominantly linked to screen ventilation (61%);
- other methods of climate management are: front and back ventilation, double inflatable plastic, summer application of calcium to whiten top, and fans for air circulation;
- all growers control their fertigation.

4.2.3. Growing conditions

Growing conditions were not quantified (this could be part of future research), however, growers' opinion with regards to the suitability of the growing conditions was asked. The response is summarized in Table 3.

Table 3. Growers' opinion with regards to growing conditions.

	Soil type		Annual rainfall		Temperature		Radiation		Altitude	
# respondents	31		33		33		33		33	
good	12	36%	15	45%	24	73%	25	76%	25	76%
acceptable	11	33%	12	36%	9	27%	5	15%	8	24%
poor	8	24%	2	6%	0	0%	1	3%	0	0%
don't know	0	0%	1	9%	0	0%	2	6%	0	0%

On the whole, growers are satisfied with the growing conditions and altitude, which varied from 1200 to 2650 masl, with an average of 2200 masl. Most concern exists with regards to soil quality, however, this was not further specified. Only once it was mentioned that drainage was bad. The major complaint regarding annual rainfall was the high amount during the months July-September, causing fungal disease problems. Regarding temperature two specific complaints were given:

- too low during the rainy season
- night frost at high altitudes during November – February.

Regarding radiation two specific complaints were given:

- too low during the rainy season
- too high (but without giving any further specifics).

4.2.4. Production

Many growers have just started their operations, and therefore, production data are scarce and tentative. Moreover, some growers are still experimenting with varieties in relation to market demands, adaptation to the temperature regime at the given altitude, and disease resistances. The overall average production is 163 stems m^{-2} y^{-1}, with a minimum of 108 stems m^{-2} $y^{-1}$and a maximum of 251 stems m^{-2} y^{-1}. There is a linear relation between altitude and annual stem production: the higher the altitude, the lower the number of stems. The main cause of this negative relation is the decreasing night temperature at increasing altitude, causing lower development rates and elongation of flush duration.

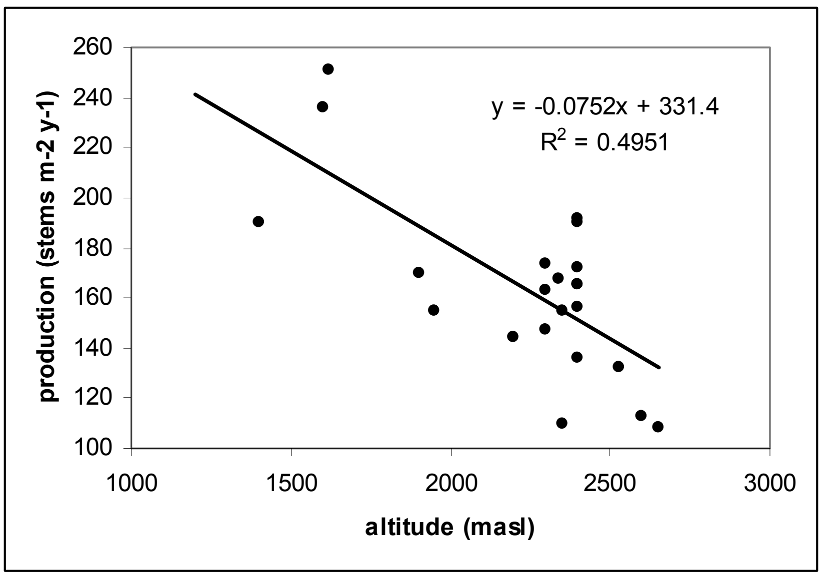

Figure 2. The empirical relation between altitude of rose farms in Ethiopia and their annual production of rose stems.

The lower number of stems stems m^{-2} y^{-1}, while day-time radiation levels and temperatures are not reduced at higher altitudes, leads to heavier, thicker and longer stems. The elongation is further strengthened by the relatively great difference between night and day temperatures.

4.2.5. Pesticide availability

According to the growers pesticide availability is not very good in Ethiopia. The vast majority of growers indidated 'medium' or 'bad' availability (Table 4). During our visit, it became clear that this should be interpreted as the supply of pesticides being irregular which results in uncertainty among growers about availability of chemicals when needed.Most farmers obtain pesticides from both local and distant (international) sources. However the majority of chemicals is imported by the growers themselves to avoid "problems". Only one pesticide formulation plant exists in

Adami Tuli with a limited range of formulations. No biological products are available. Only about 20% of the pesticides available on the market are registrered (Pers. Comm., Mohammed Dawn, Director Ambo Research).

Table 4. Availability of pesticides.

# respondents	33	
Good availability	6	18%
Medium availability	16	48%
Bad availability	11	33%
Available from source local	21	64%
Available from distant source	23	70%

4.2.6. Water availability

Most farmers use ground water, which is obtained from bore holes, during all seasons (Table 5). Only 11% of the farmers restrict the usage to the dry season. The availability of good-quality ground water is an important condition for settlement of the farm.

Table 5. Patterns of ground water use.

	using ground water		**when using ground water?**		**why using ground water?**		**ground water quality**	
# respondents	32		28		28		28	
Yes	29	91%						
no	3	9%						
Always			24	86%				
Dry season			3	11%				
Sometimes			1	4%				
Quality								
quantity					3	11%		
Availability / location					21	75%		
Availability / location, quality					2	7%		
Availability / location, quantity					1	4%		
Drinking water					1	4%		
Good							24	86%
Acceptable							4	14%

Surface water, which is obtained from rivers, is used by approximately 1/3 of the farmers (Table 6). Their majority always uses the water for reasons of good availability and good to acceptable quality.

The vast majority of growers has installed a measurement system to control irrigation; only once it was mentioned that the system was installed to sustainably use the available water.

The amounts of water used are given below, as indicated by a number of growers. Those data require further analysis (in collaboration with Ethiopian Policy Dialogue Project).

All (32) growers indicated that the amout of water during the rainy season is sufficient, and only 2 growers indicated water shortages during the dry season. Therefore, it can be concluded that at the moment water availability does not pose a problem. However, only 17 (of the 32) farmers expect that the water availability over the next 5 years will be sufficient; in other words, shortages are expected.

Table 6. Patterns of surface water use.

	using surface water		when using surface water?		why using surface water?		surface water quality	
# respondents	32		10		10		10	
Yes	10	31%						
No	22	69%						
Always			7	70%				
Dry season			2	20%				
Sometimes			1	10%				
Availability / location					8	80%		
Availability / location, quality					1	10%		
Availability / location, quantity					1	10%		
Good							5	50%
Acceptable							3	30%
Bad							2	20%

Table 7. Patterns of surface water use.

	Amount of water used			Number of irrigations per day
	during year (m^3 ha^{-1} d^{-1})	during rainy season (m^3 ha^{-1} d^{-1})	during dry season (m^3 ha^{-1} d^{-1})	
# respondents	10	19	19	14
average	52.4	28.8	50.2	5.7
min	24.0	0.0	19.0	1.5
max	83.0	50.0	80.0	16.0

All farmers (33) use drip irrigation, which is complemented by 9 growers with overhead sprinklers, and by 2 growers by hand spraying.

Only 6 (out of 33) growers treat the irrigation water for water-born diseases, as the irrigation water, coming from underground sources, is considered disease-free.

Only 3 (out of 33) growers recycle the irrigation water, and only one grower treats this water with UV. During our mission it was indicated that futures shortages, if they occur, will trigger the investment in equipment to recirculate the irrigation water.

4.2.7. Institutional context

A total of 31 growers responded to the request to indicate institutional barriers toproduction. On the whole, such barriers were indicated to be only moderately present. It was mentioned that in general the government is supporting the floriculture sector; while one grower mentioned that the government is reacting too slow to the fast growing floriculture sector. With regards to legislation, the absence of import permits for biological control agents was mentioned three times, and the lack of labour laws was mentioned once.The fact that the absence of an import permit was mentioned not more than three times seems inconsistent with the growers' opinion that this absence hampers the introduction of IPM (see paragraph 3.1.8); apparently, farmers are of the opinion that IPM is not a prerequisite for growing a rose crop *per se*, however, is highly desirable nevertheless. Bureaucracy and corruption are a problem, and their immediate effect is that 'it takes time to arrange things / to get things done'.

Table 8. Perceived institutional barriers.

	Institutional barriers by									
	government		Legislation		Bureaucracy / Corruption		Safety issues		others	
# respondents	31		31		31		31		31	
yes	2	6%	6	19%	12	39%	0	0%	7	23%
no	29	94%	25	81%	19	61%	31	100%	24	77%

Other specific issues mentioned were:
- The labour mentality of the people is difficult because of the former communistic regime;
- (management of) logistics, especially airfreight, is poor; sometimes the produce can not be sent;
- things are being stolen (even plastic from greenhouse); police surveillance should be improved;
- waste disposal is a problem;
- Importing chemicals and fertilizers can be problematic;
- infrastructure (roads, airfright facilities) is insufficient.

The succesfull introduction of Integrated Pest Management is highly dependent on the institutional setting. The technology transfer model used in the past and based on results of formal research has shown not to be adequate. A more integrated, site specific approach to development is necessary to solve the many problems related to sustainability in crop protection and production. Growers' perceptions of the risks involved in the use of sustainable methods demands local try-outs of standards that are developed elsewhere. Experts can assist growers in starting experiments and in analyzing results.

4.2.8. Actual pests and disease control

Table 9 provides an overview of the seasonality of pests and diseases. The main pests and diseases are mites, thrips, aphids and whiteflies and powdery mildew (*Sphaeroteca pannosa*) and downy mildew (*Peronospora sparsa*).

During our visit in January 2007 we have collected insects at ten locations at several altitudes (from 1700-2600 masl). Insect species have been identified by experts of the Phytosanitary Service in The Netherlands. Most mites identified and collected at the various production sites are *Tetranychus urticae*. subspecies *cinnabarius* Boisducal (common name is two spotted spidermite, red spider mite, glasshouse red spidermite and red mite). Two –spotted spider mite feeds on a wide rage of plants. It is an important pest of glasshouse crops and is commonly found on roses, beans canrnations, chrysanthemums and many other ornametals. This species is known by the PD Wageningen being present on roses from Ethiopia.

So far two thrips species have been found *Frankliniella schultzei* spp. schulltzei (Trybom) and *Megaluro thrips sjostedti* and one whitefly speices *Trialeurodes vaporariorum* (Westw.). These last species are known from interceptions by the Dutch Phytosanitary Service.

Table 9. Seasons in which pests and diseases appear according to the growers (dry season, wet season, both seasons).

Farm	Crop, if not roses	Red spidermite	Two-spotted spider mite	Thrips	Downy mildew	Powdery mildew	Botrytis	caterpillars	aphids	black spot	Agro-bacterium	cut worm
1		dry		dry	rainy	dry	rainy					
2		dry		dry	rainy	dry	rainy					
4		dry		dry	rainy	dry	rainy		dry			
6		dry		all	rainy	dry	rainy		all		both	both
7		dry			rainy	dry	rainy	rainy		rainy	both	
9		dry			rainy	dry	rainy					
10		dry		both	rainy	both						
11		dry		dry	rainy	dry	rainy	both	both			
14		dry		Sometimes	rainy	dry	rainy	both	both	both		
16		dry			rainy	dry	rainy					
17		dry			rainy	dry	rainy					
18		dry			rainy	dry	rainy					
19		dry			rainy	dry	rainy					
20		dry			rainy	dry	rainy					
21			all		rainy	dry		rainy	both			
22		all		all	rainy	dry	rainy		both			
23		dry	dry	dry	rainy	dry	rainy					
24		all		Sometimes	rainy	dry	rainy		Sometimes		both	
25		dry			rainy	dry	rainy					
26		dry			rainy	dry	rainy					
27		dry			rainy	dry						
28		dry			rainy	dry	rainy		both			
29		dry			rainy	dry	rainy		Sometimes			
33		dry			rainy		rainy					
35		dry		dry	rainy	dry	rainy	dry	dry			
12	cuttings			both	both		both					

Farm	Crop, if not roses	Downy mildew	Botrytis	Red spidermite	Powdery mildew	Thrips	Alternaria	Leaf minor flies	caterpillars	aphids	grasshoppers	black spot	cut worm	mites	Fusarium	Resoxtonia	white fly	rust	root rot	Verticillium	Beetles
3	other cut flowers		rainy			both	rainy	both	both												
5	other cut flowers	rainy	rainy	dry		dry			dry	dry	dry	rainy									
8	other cut flowers					both		both	all	dry				dry	both	both					
30	other cut flowers			dry													rainy	dry			
31	other cut flowers		rainy			both							both		both			both	both	both	both

The analyses in Tables 10-20 suggest that the cost of agrochemical inputs such as pesticides constitutes a high proportion of the cut flower farming chain, 24%. Over 92% of spraying costs go to chemicals. A medium size farm growing roses under soil conditions uses an average of 1000 litres per ha of 23 different chemicals. The actual frequency of pesticide sprays impedes the implementation of IPM procedures, particularly the use of biological control. Pesticides targeting hard-to-kill floriculture pests frequently kill natural enemies, which favors continued reliance on conventional pesticides.

The mayority of the growers are willing to innovate their control strategies. At almost all farms there are scouts responsible for the crop/pest observations. Lack of biological agents, lack of information, knowledge and training are frequently mentioned as important limiting factors .

We conclude that a more sustainable rose production implies more than a shift in farming practices. A change in training and knowledge about how to grow a good crop and sustainable pest management are inherent in the process.

We further conclude that the introduction of Integrated Pest Management including biological control in the Ethiopian rose production will not be a matter of simply changing pesticide use or adopting technology. The growing confidence of growers to be involved in and contribute to the process of developing a more sustainable rose production in Ethiopia will be the key.

Table 10. Methods of pest, disease and weed control actually used.

	Pest control			Disease control			Weed control		
	Chemi-cal	Bio-logical	Others	Chemi-cal	Bio-logical	Others	Chemi-cal	Bio-logical	Others
# respondents	32	32	32	32	32	32	32	32	31
Yes	32	1		32	1		6	0	
No	0	31	21	0	30	20	26	32	6
Cultural practice*			9			9			
ventilation and cultural practice			2			2			
ventilation and humidity control			0			1			
weeding									25

* cultural practice is not specified

General remarks by the growers on pest and disease control are:
- no biological control agents are available
- chemical control is easy, effective, and the only method available so far.

Preventive (prophylactic) spraying is customary.

Table 11. Responses to question 'Who recommends you on the applied pest control methods?'

# respondents	32
trained supervisor - general	12
trained supervisor - farm manager	7
trained supervisor - production manager	8
shop	0
extension officer	0
other farmers	8
Consultants*	18
internet, literature	6

chemical supplier	4
experience	1
main company in home country	1

*Consultants come from The Netherlands (8), Israel (8), Ethiopia (1)

Table 12. Level of training of the person in the farm responsible for the pesticide management

# respondents	32
university degree	28
training certificate	1
training at farm	4
practical experience	8

Table 13. Responses to question 'If no other methods than chemical control is used, why are they not used?'

# respondents	31
lack of knowledge	0
lack of time	0
lack of information	4
lack of alternative products	26
Price	2
Others	14

Remarks: Biological control agents can not be imported (8), consultant (from Israel) is not recommending biological control (1), too many different plant varieties for biological control (1), also using cultural methods (1), little pest and disease problems (1).

Table 14. Methods of pesticide application.

# respondents	32
knapsack	22
central spray	22
mobile tank with motor	1
tractor spray	1
Hand pulled tank with pump	1
Tractor spray, motor spray	1
Central spray, tank with motor	2
Central spray, mist blower	1
Central spray, tank sprayer	1
Motorized knapsack sprayers; tractor tank sprayer	1

Knapsack generally for spot spraying

Table 15. Responses to question 'Who recommends you to use a cocktail / mixtures?'

Cocktails were used by 24 (out of 32) farmers.

trained supervisor	20
other farmers	4
consultants	15
internet, literature	2
chemical supplier	2
label of chemical	2

Consultants come from The Netherlands or Israel.

Table 16. Method and frequency of scouting.

# respondents	32
scouting	32
sticky traps	3
visual observations	32
laboratory	1
# scoutings per week	
av	5.9
min	1
max	14

Table 17. Responses to question 'Do you consider imported biological control agents as possible solution?'

# respondents	32
known	1
possible solution	28

The one farmer that knows of a biological control agent, should be taken with caution.

Table 18. Crop losses due to pests and diseases.

	Average % of traded product that is rejected by the market due to pests and/or diseases	Crop losses (%) per cropping season due to pests and diseases	Crop losses (%) due to pest and diseases during rainy season	Crop losses (%) due to pest and diseases during dry season
# respondents	30	25	7	3
av	1.3	4.5	24.3	3.3
min	0	0	10	2
max	10	20	40	5

Crop losses due to the presence of pests and diseases, as estimated by the growers, are fairly low. If correct, then this is due to the high spraying frequency.

Table 19. Satisfaction with regards to current methods of pest management.

	Satisfied with current pest management	Willing to change?
# respondents	32	32
satisfied	23	
not satisfied	9	
change		27
not change		5

Reasons for not being satisfied:

- Chemicals for Red Spidermite are not always available; Because of the Spidermite resistance
- Sprayers need more training, difficult to spray during rainy season (open field)
- some chemicals are not satisfactory
- Shortage of chemicals; not all chemicals that are needed are available
- Downy mildew is difficult during rainy season
- Not able to control all P&D satisfactory

With regards to change:

- Would like to use biological (18)
- More environmental (1)
- Would like better/cheaper means (6)
- Increased availability of chemicals (2)

Table 20. Responses to question 'The major ristrictions according to you in the development of integrated pest management? (each grower could mention three at most).

	restrictions
# respondents	29
do not know	8
lack of info	13
no biological available	14
lack of knowledge	7
lack of training	9
lack of technology	1
good record keeping	1
Good monitoring of greenhouse climate	1
no interest	1

5. Synthesis of current situation

5.1. Visits and discussions

We met with a great number of growers, scientists and representatives from ministires (see the itenary), with whom we spoke at length. We do not report on each individual discussion, however, integrate the insights obtained in the synthesis given in the following paragraph.

5.2. Synthesis

Synthesising all information, the discussions with growers, scientists and representatives from ministries yielded the following main results:

1. All sectors strongly support the introduction of Integrated Pest Management in Ethiopian rose cultivation. This is a very valuable prerequisite, which enables an immediate start.
2. Valuable linkages exist between private and public sector. There is a close collaboration between the rose growers at one side, and the Ministries, the Plant Protection Research Centre, and Jimma University at the other side. The IPM R&D plan should build upon those existing links.
3. Surveys on flower pests have been conducted in the past by the Plant Protection Research Centre in Ambo. This is important knowledge to build on, as it enables prioritization and risk assessment.
4. Spider mites are the major problem. In the dry season, this pest is the most serious problem, and is the cause of heavy chemical spraying. Therefore, it is recommended to be the trial pest in the experiments for IPM introduction.
5. Applied rose-specific research has recently started. The Plant Protection Research Centre at Ambo is in the process of constructing a greenhouse that can accommodate applied research on roses. Linkeages exist between PPRC and a commercial rose grower, who can fulfill a training-role and support the build-up of the capacity to grow a rose crop. It was confirmed by Dr. Soloon Assefa and Dr. Mohammed Dawd that a assigned person at PPRC will assume the role of coordinator. We consider this crucial to the success of the experiments.
6. Higher eduction possibilities are available. The college of Agriculture and Veterinary Medicine at Jimma knows a Horticultural Department. Part of the curriculum is a Practical Internship for a number of months. We propose to invite two students to each rose farm to work and study in the trials. At the moment, the Practical Internship always falls in the months of July and August. From an IPM perspective, this is less attractive, as these months fall in the rainy season when insect densities are low. Also, students' presence is required all year through.
7. Ethiopian and foreign growers identified for biological control and further on-farm research. Four enthusiastic growers were identified, who were willing to house the on-farm IPM trials and who met a limited number of basic criteria (see paragraph 4.3.1).
8. The import license request being processed; if granted, trials can start rapidly. At the moment of our mission, the import licence request had been submitted by Dr. Mohammed Dawd of PPRC, and was being processed by the Plant Protection Department of the Ministry of Agriculture and Rural Development. Once approved, trials can start very rapidly, as the intended associated supplier of biological control agents (Koppert) has put in place the logistics and has specified plans for consultancy support.
   The import licence request had been submitted by PPRC, as the Ethiopian Agricultural research Institute has the mandate to import for (controlled) experimental use of biological control agents.
9. A standard protocol for the import of biological control agents does not yet exist. Trusting that the IPM experiments will be successful, there will be a rapidly increasing demand for biological control agents. These will have to be imported by a variety of companies (*e.g.*, Koppert (The Netherlands), Real IMP (Kenya), Syngenta (USA), Kibbutzxxx (Israel)). This requires a brief but effective import protocol, which will have to be developed under the authority of the Minsitry of Agriculture and Rural Development.

6. Priorities to be addressed

The analysis of the current situation in Ethiopia reveals a number of research and development (R&D) issues that need to be addressed before and during the implementation of Integrated Pest Management in the Ethiopian rose sector. These priorities concern the enabling environment, research priorities, and knowledge exchange.

- Enabling environment
  - Risk assessment import beneficials: The import of beneficials must comply to certain minimum standards of product quality and safety for the Ethiopian biodiversity.
  - Permit procedure – embedded in rules and legislation: Commercial import of beneficials is only possible if the permit procedure is clear, smooth, and embedded in rules and legislation.
  - Institutional linkeages and partnerships: Integrated Pest Management needs good institutional lnkeages and partnerships to enable high-qualtiy research, knowledge exchange, and flow of goods.
- Relevant research priorities
  - On-farm research: Research at farms is required to assess, for example, action thresholds.
  - Applied research: Applied research at a research station is required to determine, for example, compatibility with specific pesticides and fungicides.
  - Post-graduate research: Further research is required to generate in-depth knowledge and management tools, and to obtain a group of Ethiopian scientists that guarantees the continuation of IPM in Ethiopian floriculture.
- Knowledge exchange
  - Demonstration trials: Normally, growers are best convinced to accept a newly introduced technology if they have visually seen its effect. For this reason, demonstration trials are absolutely necessary; fortunately, all selected growers (see paragraph 4.3.1) have agreed to welcome colleague growers to their greenhouses.
  - Study groups: Exchange of knowledge among farmers is highly stimulated in a group-environment, in which experiences and thoughts are exchanged.

6.1. Enabling environment

6.1.1. Risk assessment

The import of beneficials must comply to certain minimum standards of product quality and safety for the Ethiopian biodiversity. Risks can be separated in risks directly associated with the product (= the biological control agent), risks for the environment and workers' health, and risks for the farm.

1. Incorrect pest identification. The first prerequisite is a correct pest identification, as an incorrect pest identification leads to the application of an incorrect biological control agent, which is ineffective. This correct identification is the responsibility of the relevant research centre (in Ethiopia, the Plant Protection Research Centre).

   With regards to spider mite and thrips, a number of samples have been taken from Ethiopian farms, and identified see 3.1.8. Material has been collected in January 2007 but this has to be repeated several times (during dry/wet season, at high/low temperatures).

2. Incorrect organisms in the biological control agent. The agent is not sufficiently effective or the biological control agent is contaminated with dangerous/quanrantaine insect species. This is the full responsibility of the suppliers of the biological control agent. In case of The Netherlands, random identifications are performed by the Plant Protection Service (part of the Ministry of Agriculture) in the country of origin, in which the supplier is located (see figure 3).

Besides, both in the EPPO region (say, EU also including countries such as Israel) and the USA lists have been developed of biological control agensts that do not require a permit for inter-state shipment. For the EPPO region and the USA this are the List of Biological Control Agents, and the Exclusion list (Entomophagous and Entomopathogenic Biological Control Agents Not Requiring a Permit for Interstate Shipment), respecitively. All biological control agents that are mentioned on those lists do not require a permit to be shipped from one country to another country. Still to check: when is an agent placed on this list?

The biological control agents for spider mite and thrips (*Phytoseiulus persimilis, Neoseiulus californicus, Amblyseius cucumeris* and *A. swirskii*) are on those lists.

3. Low activity of the biological control agent. If the biological control agent is not sufficiently active, the its capacity to suppress the pest will be insufficient. The supplier is responsible for this, and a reliable supplier will have developed advanced storage and transport systems that ensure a sufficient high quality at the moment of application. In Europe, batch-wise control according the IOBC (International Organisation for Biological and Integrated Control of Noxious Animals and Plants) guidelines takes place.

The biological control agents for spider mite and thrips for which an import permit has been requested, meet those criteria.

4. Exotic biodiversity for natural fauna is introduced. It can never be fully excluded that a biological control agent escapes to the outside environment. It is understandable that this is of major concern to the Ethiopian authorities, who are responsible for Ethiopia's biodiversity. The following points are relevant for consideration:
    a. If a biological control agent already occurs in the country, then there is no risk to import the same species. Of course, the genetic make-up of each animal differs, and therefore the genetic make-up of the introduced population of biological control agents will differ from the native population. However, in many cases they will form part of the same gene-pool, moving across continents.
    b. The following hurdles have to be taken by the biological control agent: the agent has to move to the outside environment, the agent has to find pest organisms to predate on, and the agent has to reproduce.
        i. **Mites**: predatory mites have no wings and operate on and around the place of introduction in the greenhouse. Hence it is very unlikely that they will have any effect or development outside the greenhouse. They are extremely specific and do not survive when red/two spotted spider mites are absent.
        ii. **Parasitoids**: most parasitoids are flying insects. That means they are mobile, but at the same time parasitoids are very host-specific, that means they will die when there is no pest.
        iii. **Micro-organisms and entomopathogenic nematodes**: these Biological Control Agents are even less mobile than mites and do not tend to reproduce on the pest. From point of view of the fauna, no special risk.
        iv. **Other predators**: that have a wide range of food sources, and/or can reproduce on plants without pests. For this category a thorough risk assessment is important.

        (Source: Koppert).

    The List of Biological Control Agents (EU) and the Permit for Interstate Shipment (USA) are based upon broad expert knowledge, including the risk of affecting biodiversity. Biological Control Agents on those lists are considered safe for biodiversity.

The biological control agents for spider mite and thrips belong to the group of specific predatory mites and therefore pose very low risks. Their import in 60 countries world-wide has not created any know problem, and never a permit was withdrawn.

5. Workers' health is affected. It is potentially possible that a worker is allergic to a biological control agent. It is the responsibility of the supplier to test the product for this. The List of Biological Control Agents (EU) and Permit for Interstate Shipment (USA) comprise allergy tests.

The biological control agents for spider mite and thrips belong are on the mentioned lists, and therefore have passed allergy tests.

6. Yield and quality of rose is reduced. Improper application of the biological control agent can result in pest levels that remain too high, and in reduce yield and quality of the harvested roses. This is the responsibility of the grower. The risk can be managed through training and technical support, research on the efficacy of predators (PPRC at Ambo, college of Agriculture and Veterinary Medicine at Jimma, WUR) and growers' participation in study groups (WUR, Training Centre).

Specifically for the spider mite control trials, interested growers have explicitely indicated that they take responsibility for risks.

7. The crop is attacked by the biological control agent. If the crop is attacked by the biological control agent, then reduction of yield and quality may be the consequence. It is the responsibility of the supplier that the biological control agent does not do this. For reliable suppliers, in country of origin, one of the criteria to select Biological Control Agents is their inability to attack plants.

The biological control agents for spider mite and thrips have been positively tested for their inability to attack rose plants.

Our overall conclusion is that for the biological control agents for spider mite and thrips, all risks have been adequately dealt with.

Table 21. Format for risk assessment of import of biological control agents. The given example is spider mite and thrips with Phytoseiulus persimilis and Neoseiulus (Amblyseius) californicus, A. cucumeris, A. swirskii

RISK	SUGGESTED RESPONSIBLE ENTITY	HAS RISK BEEN DEALT WITH?	RISK MANAGEMENT
PRODUCT			
Incorrect pest identification	research	yes	Correct identification (PPRC & WUR)
Incorrect organisms in biological control agent	supplier	yes (for reliable suppliers)	random identification by Plant Protection Service in country of origin
		yes	*Phytoseiulus persimilis, Neoseiulus californicus, Amblyseius cucumeris* and *A. swirskii* are on the List of Biological Control Agents of the EPPO region, and the Exclusion list (Entomophagous and Entomopathogenic Biological Control Agents Not Requiring a Permit for Interstate Shipment) of the USA
Low activity of biological control agent	supplier	yes (for reliable suppliers)	batch-wise control by supplier according IOBC guidelines (for Europe)
			advanced transport & storage system organized by supplier
ENVIRONMENT AND WORKERS' HEALTH			
exotic biodiversity for natural fauna is introduced	Ministry of Agriculture and Rural Development	yes	Safety means: if mentioned predators escape, there is no harmful effect on the ecosystem biodiversity
			List of Biological Control Agents (EU) and Permit for Interstate Shipment (USA) are based upon broad expert knowledge, resulting in safe import in 60 countries world-wide
workers' health is affected	supplier	yes (for reliable suppliers)	List of Biological Control Agents (EU) and Permit for Interstate Shipment (USA) comprise allergy tests
FARM			
yield and quality reduction rose	grower	yes	Training & technical support through research of efficacy of predators (PPRC, Jimma, WUR)
			Interested growers have indicated that they take responsibility for risks
			Growers' participation in study groups (WUR, Training Centre)
crop attacked by biological control agent	supplier	yes	In country of origin, one of the criteria to select Biological Control Agents is their inability to attack plants

Ministerie van Landbouw, Natuur en Voedselkwaliteit

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landbouw, natuur en voedselkwaliteit

Nr.: K2006 - 309 - DECLARATION

The undersigned, Director of the Plant Protection Service of the Netherlands, declares:
- that the consignment described below is destined for biological control;
- that the identity of the species in the biological agents in this consignment has been confirmed by the Plant Protection Service of the Netherlands;
- that the consignment has been found free from quarantine pests and/or other harmful organisms.

Name and address of exporter : Koppert BV
Nom et adresse de l'expéditeur : Postbus 155
Name und Adresse des Absenders : 2650 AD Berkel en Rodenrijs. The Netherlands

Name and address of consignee : Koppert Kenya
Nom et adresse du destinataire : 2nd Avenue Cargo Village – J.K.I.A.
Name und Adresse des Empfängers : P.O. Box 41852
00100 Nairobi – Kenya

Quantity and name of produce : Sample of parasites/predators
Quantité et nom du produit : Enchantillion des parasites
Quantität/Menge und Name des Produktes: Muster der Parasiten

Scientific name
Nom latinique
Wissenschaftliche Name :

Amblyseius californicus, *Amblyseius cucumeris*, *Amblyseius degenerans*, *Anagyrus pseudococci*, *Aphelinus abdominalis*, *Aphidius swirskii*, *Aphidius colemani*, *Aphidius ervi*, *Aphidoletes aphidimyza*, *Aphytis melinus*, *Chrysoperla carnea*, *Heterorhabditis bacteriophora*, *Cryptolaemus montrouzieri*, *Dacnusa sibirica*, *Diglyphus isaea*, *Encarsia formosa*, *Ephestia kuehniella (sterilized eggs)*, *Eretmocerus eremicus*, *Eretmocerus mundus*, *Feltiella acarisuga (=Therodiplosis persicae)*, *Heterorhabditis megidis*, *Hypoaspis aculeifer*, *Hypoaspis miles*, *Steinernema carpocapsae*, *Leptomastix dactylopii*, *Macrolophus caliginosus*, *Coccidoxenoides perminutus*, *Metaphycus bartletti*, *Ophyra aenescens*, *Orius insidiosus*, *Orius laevigatus*, *Orius majusculus*, *Phytoseiulus persimilis* *), *Steinernema feltiae*, *Trichogramma brassicae*, *Trichoderma harzianum*, *Verticillium lecanii*

*) may contain a number of Tetranychus urticae as foodsource during transport

Rhopalosiphum padi } used in rearing system
Sitobion avenae } for predators of lice

Wageningen,

MINISTERIE VAN LANDBOUW, NATUUR EN VOEDSELKWALITEIT
PLANTENZIEKTENKUNDIGE DIENST
NEDERLAND

Drs. R.J.T. van Lint
Director

Figure 3. Dutch Ministerial declaration: product purpose = biological control; identity of species; free from quarantine pests and other harmful organisms.

6.1.2. Permit procedure

The establishment of a procedure for granting a permit to import biological control agents is part of the Phytosanitary sub-project. Some proposed elements for the Ethiopian permit procedure are specified in Table 22.

Table 22. Some proposed elements of the permit procedure to import biological control agents.

Requirement to be fullfilled	**Who to fullfill**	**Remarks**
Has pest been identified?	PPCR	
Has biological control agent been identified?	Supplier	
Has quality of biological control agent been guaranteed: - identity - activity - allergy-free - inability to attack plants)	Supplier	Ministerial (e.g., Phytosanitary Service) declarion from country of origin: product purpose = biological control; identity of species; free from quarantine pests and other harmful organisms (see example in Figure 3)
Is biological control agent on the List of Biological Control Agents (EU) and the Permit for Interstate Shipment (USA)?	Supplier	
Is there a memorandum of understanding between supplier and PPRC?	Supplier, PPRC	If there is a research component involved, which is not necessarily always the case.
Careful consideration.	Supplier, MoARD	If the biological control agent is **not** on the List of Biological Control Agents (EU) and the Permit for Interstate Shipment (USA).

6.1.3. Institutional linkeages and partnerships

Research demands very intensive co-operation, and development of a succesful sector demands public-private, public-public and private-private parternships. An option to structure all those linkeages and partnerships, is the establishment of an Ethiopian IPM alliance and the appointment of a research coordinator. The organisational structure will be further discussed during the next visit.

The following institutions play a role in the development of an R&D plan for IPM in Ethiopia:

- The Plant Protection Department (PPD) of Ministry of Agriculture and Rural Development (MoARD).1) PPD is the responsible Ethiopian institution for the development of an R&D plan for IPM in Ethiopia. 2) No standard import procedure for biological control agents is currently available in Ethiopia. PPD has established an ad-hoc working procedure, which involves an expert group that recommends on the import permit.
- The Ministry of Trade and Industry (MTI).
- The Ethiopia Institute of Agricultural Research (EIAR). EIAR takes part in the expert group that recommends on the import permit, and is the umbrella organization of PPRC.
- The Plant Protection Research Centre (PPRC), at Ambo, of the Ethiopian Agricultural Research Institute. PPRC is involved in on-farm research activities, and is responsible for applied research activities.
- The College of Agriculture and Veterinary Medicine, Jimma University. Jimma University is involved in on-farm research activities through the supply and guidance of students, and is responsible for MSc and PhD research activities.
- The Ethiopian Horticulture Producers and Exporters Association (EHPEA). EHPEA has a facilitatory role in the organization of farmers' participation.
- Suppliers of biological control agents. Besides supplying the biological control agent, the suppliers are involved in the on-farm trials and other research activities.
- The Royal Netherlands Embassy. The Royal Netherlands Embassy has an important faciliatory role.

- <u>Wageningen University and Research Centre (WUR)</u>. WUR provides scientific consultations at most issues.
- <u>USAID</u>. USAID also stimulates the introduction of IPM.

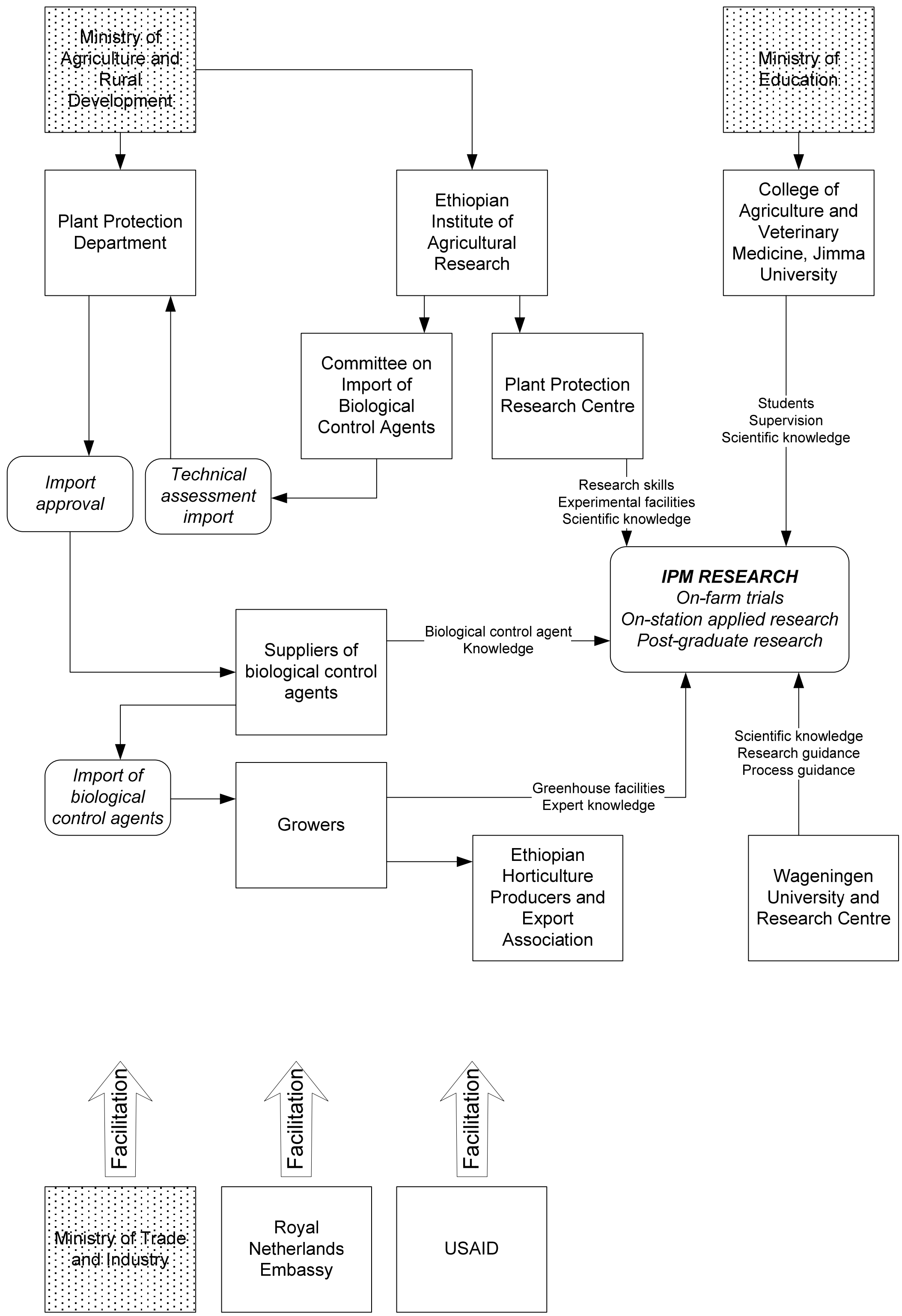

Figure 4. Schematic representation of institutional linkages relevant to IPM research and development in Ethiopia.

6.2. Research priorities

Attention must be given to both formal and informal research. What we mean is that two different research systems have to be combined in which the Grower First approach should be the basis for IPM (van Huis and Meerman, 1997)

We suggest that informal (on-farm) research and development capacity (Growers First approach) should be the starting point, both in problem definition and technology development. Instead of promoting the transfer of ready-made techniques (formal research) developed by scientists and transferred to the growers (TOT model) as fixed prescriptions, we need site-specific agro-ecological approaches. Transfer of Technology using a Training and Visit model poorly fits the needs and priorities of growers (e.g. for Africa, see Richards, 1985). Formal research must be designed in such a way that it allows for flexibility and will not turn growers into consumers of technology (Waibel, 1993). Formal and informal research do not exclude each other; rather, they support each other and are both necessary to achieve certain research goals.

A number of examples are given in Figure 5. The examples are not meant to be comprehensive, or may even deserve a very different position in the figure if other research issues are considered. For example, researching the agronomic practices that affect biological control can be done in a very informal manner in the greenhouse, recording the management practices and environmental conditions as they come along, and carefully monitoring the resulting dynamics of crop, pest and biological control agent. It can also be done in a very formal setting under strictly controlled conditions to, e.g., determine the effect of air relative humidity on crop, pest and biological control agent.

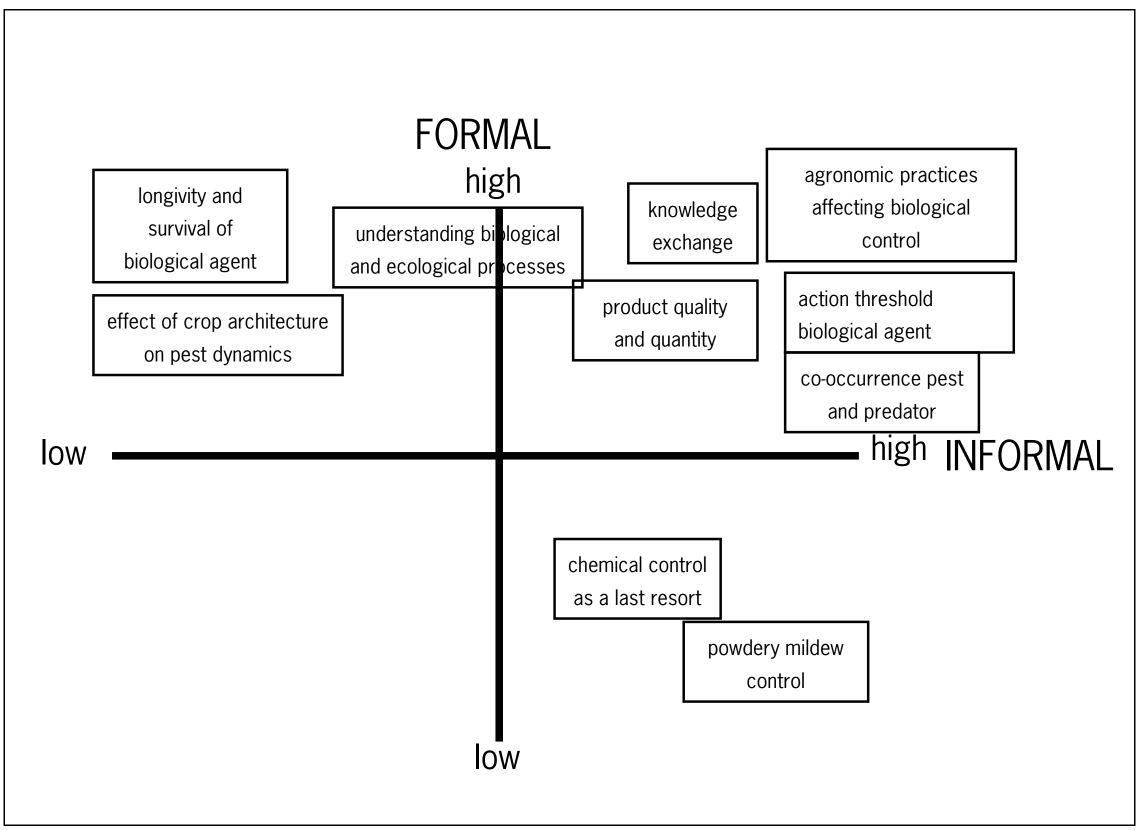

Figure 5. Examples of IPM-related research, organized on the basis of their formal and informal research components.

Each time again, the research question must be clearly defined and careful balancing demanded output and research possibilities will determine the research method. The latter will always be some combination of formal and informal research.

In consultation with the stakeholders a number of short and long-term research priorities were defined. Short-term research issues, in which the efficacy of spider mite control is tested, should be addressed as soon as the import permits for biological control agents has been granted, and the agents are available.

Table 23. Suggested short-term research trials to support the introduction of IPM.

Trial number	1	2	3
Research subject(s)	Scout plan	Measure compatibility of biological control agent with pesticides	Measure compatibility of biological control agent with powdery mildew control through fungicides
	Release of biological control agent in commercial greenhouse, monitoring pest/predator density	Release in greenhouse of 2 biological control agents based on action thresholds	
Involved institutions	Growers, PPRC, Jimma, WUR, supplier	Growers, PPRC, Jimma, WUR, supplier	Growers, PPRC, Jimma, WUR
Location	Grower's greenhouse	Grower's greenhouse	Grower's greenhouse

Some examples of medium to long-term research subjects are suggested below. In consultation with partners, these subjects will be more precisely defined, also in terms of on-farm research, applied research and post-graduate research.

Table 24. Suggested long-term research subjects for MSc and PhD students.

MSc subjects	PhD subjects
Development of action threshold for spider mite control	Whitefly and thrips control by *Amblyseius swirskii* in relation to altitude
Development of action threshold for thrips control	Model development of the rose – thrips – *A. swirskii* ecosystem and application in Ethiopian IPM
Quantification of climate and crop conditions	Shoot quality in relation to altitude
	Supply chain management of roses
	Knowledge-exchange learning process

6.3. Knowledge exchange: "learning by doing"

In the R&D programme system-focussed approaches have to lead to growers'responsive and locally adapted technologies, which will support the sustainable rose production in Ehtiopia. The adoption of Integrated Pest Management requires decision-making at different stages in the cultivation process and a technology development process which needs science. Therefore linking formal/informal research approaches to technology development on the farm and growers participation are important. An advantage of using a participatory approach is both a learning process for researchers, students and growers an provide immediate feedback to researchers. Another advantage of using a participatory approach is the opportunity for researchers to do more in a very short span of time.
Study groups and group work (growers, Ambo Research, Jimma University, scouts) will stimulate reflection on measurements, and experimentation with new methods and the acceptance of new norms of appropriate behaviour

(GAP, Eurogap, MPS certification programme). Central in this approach is "learning by doing". The approach will be observation intensive and relies on observation and monitoring of the state of the crop and the pests. This typically requires new ways of "making things visible" and feedback loops (with a continous feedback loop in the centre):

- Regular field observation and measurement will be the basis for decision-making
- We will use record-keeping to make economic results transparent
- Exchange of information and experience among co-learners

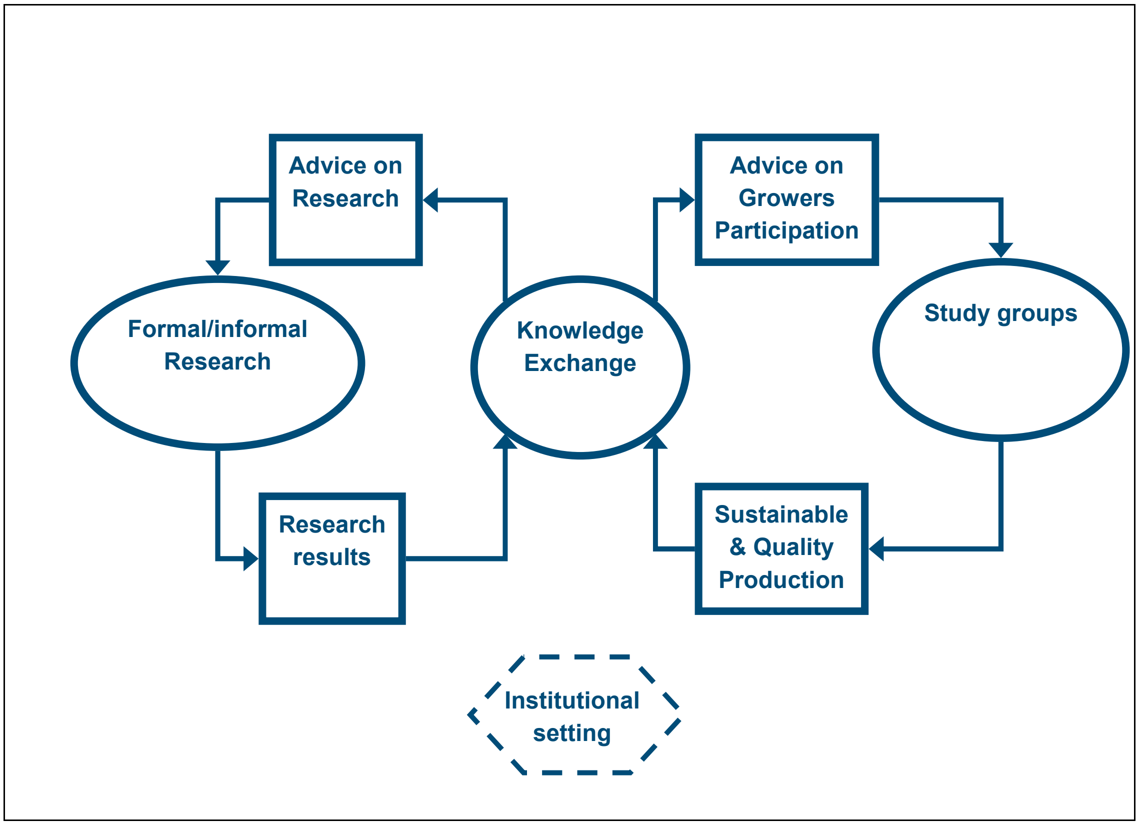

Figure 6. Graphical representation of the knowledge exchange process.

6.3.1. Demonstration trials

It is proposed that demonstration trials are conducted at a limited number of farms. The motto is 'Small and solid'. Through visits by colleague farmers and study groups the results of the demonstration trials during the first year will be disseminated. In later years, up scaling will take place (see paragraph 4.3.3).

Ten growers were visited. They had been selected on the basis of forehand assumptions with regards to their willingness to participate in the trials, and variation in altitude. The final growers were selected on the basis of the following criteria:

- willingness to participate in an IPM trial
- presence of scouts
- technically advanced
- permitting students
- willing to participate in study groups

It is important that rose farms at various altitudes participate in the trial, as each altitude knows its own climate with associated crop, pest and pathogen dynamics. A farm at an altitude of approximately 2000 masl was not identified, as time was too short to visit a sufficient number of farms. A farm at Debre Zeit would be a suitable option.

Table 25. Selected growers for the IPM introduction trials.

Name of grower	**Ziway**	**?**	**Lafto**	**Managesha**	**J.J. Kothari**
Altitude (masl)	1700	2000	2300	2550	2600
Nationality of owner	Dutch		Dutch	Ethiopian	Indian
Compartment acreage (ha)	9		0.9	0.8	1
Number of varieties in test compartment	3		1	> 1	> 1

6.3.2. Study groups

Study groups and groups that take up specific tasks (growers, PPCR, Jimma University, scouts), will be formed before the first on-farm trials. This will stimulate individual and collective reflection on measurements, experimentation with new methods, and the acceptance of new norms of appropriate behaviour (GAP, Eurogap, MPS certification programme),

6.3.3. Upscaling R&D IPM in Ethiopia

After the first year of trials at a limited of rose farms, IPM can be up-scaled. This development has to be specified in close collaboration with Ethiopian priorities, private sector interests, and chances to successfully implement the technology.

Up-scaling can be in three areas:

- other pests, diseases and biological control agents
- acreage
- crops (e.g., beans, food crops)

7. Proposed plan of action

The proposed summary plan of action for 2007-2008 is given in Table 26.

Table 26. Proposed plan of action for 2007-2008.

When	**Who**	**What**
Feb 2007	Min. Agric. Rur. Dev.	Approved import permit for four predators
Feb 2007	Min. Agric. Rur. Dev. & WUR	Concise import protocol
Feb-July 2007	Growers, PPRC, Jimma, WUR, supplier	Trial 1: First on-farm IPM trials
April 2007	Jimma, PPRC, WUR	MSc proposals
Sep 2007	Min. Agric. Rur. Dev.	Import permit for other beneficials
Aug 2007 - Jan 2008	Growers, PPRC, Jimma, WUR, supplier	Trial 2
2008	Growers, PPRC, Jimma, WUR	Trial 3
2008 (or earlier)	Jimma, PPRC, WUR	PhD proposals
2008	All	Upscaling

In a planned meeting in March 2007, the details of this work plan will be developed, including a budget.

8. Itinerary

Mo 15 Jan	Evening	Flight Amsterdam – Addis Ababa
Tue 16 Jan	Morning	Arrival to Addis Ababa Airport Checking in to hotel Golf Club Meeting with Geert Westenbrink, Agricultural Councellor. Lunch at Geert Westenbrink's place.
	Afternoon	Start-up meeting with - Geert Westenbrink - Fikre Markos, Head, Plant Protection Department, Ministry of Agriculture and Rural Development - Muhammed Dawd, Director Plant Protection Research Centre at Ambo - Sisay Habte, Assistant Executive Director, Ethiopian Horticulture Producers and Exporters Association - Lemma Gebeyehu, Plant Protection Department, Ministry of Agriculture and Rural Development Visit to farm: - Lafto Rose farm (manager Frans Diedens) at **xxxx**
	Evening	Rest
Wed 17 Jan	Morning & afternoon	Visit to farms: - Roses: Ziway Roses (technical director Peter Holla) at Ziway - Vegetables: Van der Torre Import Export (managing director Jan Prins) at Ziway - Roses: AQ Roses (**position??** Frank Ammerlaan) at Ziway - Outdoor beans: Ethio Flora Farm (farm manager Murgeta **???)** at **xxxx** - Outdoor beans: Ethio Vegetables and Fruits (**xxxx**) at Koka
	Evening	Preparation wrap-up presentation
Thu 18 Jan	Morning	- Travel to Ambo - Meeting with Muhammed Dawd and staff of Plant Protection Research Centre at Ambo - Lunch offered by Muhammed Dawd
	Afternoon	Visit to farms: - Roses: Linssen Roses Ethiopia (Mr. Linssen senior) at **xxx** - Roses: Garot (Saladin Iz) at **xxx**
	Evening	Preparation wrap-up presentation
Fri 19 Jan	Morning	Meeting with - Glenn Humphries, foreseen Head Horticultural Training Centre - Ian Chesterman, USAID Horticulture Sector Manager - Richard Pluke, Fintrac Senior Agronomist/ Entomologist - Geert Westenbrink - Sisay Habte
	afternoon + evening	Preparation wrap-up presentation
Sat 20 Jan	Morning	Visit to farms: - Roses: J.J. Kothari & Co. (Mr. Aravinda Harirao) at **xxx** - Roses: Managesha Flowers (Owner Mr. Solomon Sebekatu) at **xxx**
	Afternoon	Preparation wrap-up presentation
	evening	Dinner with Geert & Wouke Westenbrink and Glenn Humphries
Sun 21 Jan	Morning	Preparation wrap-up presentation
	Afternoon	Leisure
	Evening	Preparation wrap-up presentation
Mon 22 Jan	Morning	Report writing
	Afternoon	Meeting with Geert Westenbrink Meeting with delegation of the College of Agriculture and Veterinary Medicine,

		Jimma University - Dr. Dhuguma Adugna Debele, Dean - Dr. Fikre Lemessa, Senior Pathologist
	Evening	Dinner with Dhuguma & Fikre. Finalization of wrap-up presentation
Tue 23 Jan	Morning	Wrap-up meeting with: - Fikre Markos, Head, Plant Protection Department, Ministry of Agriculture and Rural Development - Merid Kumso, Leader, Plant Quarantine Team - Muhammed Dawd, Director, Plant Protection Research Centre, at Ambo - Dhuguma Adugna Debele, Dean, College of Agriculture and Veterinary Medicine, Jimma University - Fikre Lemessa, Pathologist, College of Agriculture and Veterinary Medicine, Jimma University - Lemma Gebeyehu, Plant Protection Department, Ministry of Agriculture and Rural Development - Geert Westenbrink, Agricultural Councellor, Royal Netherlands Embassy Meeting with Dr. Adhanom Negasi Hailemariam, Special Advisor to the Minister, Ministry of Trade and Industry. Meeting with Dr. Fantay Biftu, General Advisor to Minister, Ministry of Trade and Industry.
	Afternoon	Lunch at Geert Westenbrink's place. Meeting with Dr. Solomon Assefa, Deputy Director General, Ethiopian Institute of Agricultural Research
	Evening	Flight Addis Ababa - Amsterdam
Wed 24 Jan	Morning	Arrival to Amsterdam Airport

9. Addresses

Persons met with

Name	Function	Organization	Address	Phone	Email/web/fax
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???	Farm manager	Ethio Vegetables and Fruits	Koka		
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Mr. Seifu Bedada	Board member	EHPEA, Dire Highland Flowers			dhf@ethionet.et
Mr. Yidnekachew Ayele	Board member	EHPEA			

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